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RESEARCH

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Prediction of acute cerebrovascular stroke disability using mSOAR score (Stroke subtype, Oxfordshire Community Stroke Project, age, mRS and NIHSS)

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Abstract

Background Stroke is among the most prevalent causes of disability. An easy reliable tool to predict stroke outcomes will help manage neurological and non-neurological events and rehabilitation. The modified SOAR (mSOAR) score, which includes stroke subtype, Oxfordshire Community Stroke Project (OCSP) classification, age, pre-stroke modified Rankin score (mRS), and National Institutes of Health Stroke Scale (NIHSS) is simple and easily calculated prognostic tool. The objective of this research was to test the ability of the mSOAR score to predict post-stroke disability as measured by mRS at discharge and 1 month after stroke onset.

Results One hundred stroke patients (aged ≥ 18 years) were included. All subjects underwent complete neurologic examination, non-contrast head computed tomography. OCSP classification, Stroke subtype, NIHSS, and mRS score on discharge and 1 month after stroke onset were assessed for all patients. The mSOAR score was significantly correlated with mRS on discharge, after 1 month of stroke, and with the length of hospital stay. mSOAR score had high sensitivity and specificity for predicting moderate-to-severe disability on discharge and after 1 month of stroke onset.

Conclusion The mSOAR is an excellent and accurate tool for predicting the severity of disability on discharge and 1-month post-stroke.

Keywords mSOAR score, Stroke, Disability

Background

Stroke is the second cause of mortality worldwide [1] and long-term disability, as about 50% of patients will have a chronic disability [2]. The physical disability and psychological and social effects of stroke are distressing for the patients and their families. Therefore, reliable recovery prediction tools will assist the medical staff in fulfilling the expectations of patients and their families [3].

There have been many prognostic tools to predict early mortality and post-stroke disability, but some are complicated and consume much time and effort [4]. Modified SOAR (mSOAR) is an easy score using imaging and clinical data in the initial assessment of the patient. It comprises the National Institutes of Health Stroke Scale (NIHSS), Oxfordshire Community Stroke Project (OCSP) classification, stroke subtype, pre-stroke modified Rankin score (mRS), and age [5].

The objective of this research was to test the ability of the mSOAR score to predict post-stroke disability as measured by the mRS at discharge and after 1 month, duration of hospital stays, and mortality within 30 days of stroke onset.

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Methods

This prospective cohort study comprised 109 patients admitted in the stroke unit between November 2021 and April 2022 with the diagnosis of acute ischemic or hemorrhagic stroke. The data of 9 patients who died were omitted.

Patients aged ≥ 18 years, both males and females were included. We recruited patients suffering from acute ischemic stroke, received intravenous thrombolysis, mechanical thrombectomy, or conventional antiplatelet treatment, also patients suffering from acute intracerebral hemorrhage who received conservative treatment or underwent surgical intervention. All patients were hospitalized within 24 h after the stroke onset.

Patients with transient ischemic attacks (TIA), stroke mimics as for example, seizures, head trauma, and hypoglycemia, subarachnoid hemorrhage were excluded. Admission after 24 h from stroke onset and presence of any associated medical disease which affects the neurologic condition of the patient, such as renal disease, liver disease, thyroid disease, severe infection, uncontrolled diabetes mellitus, and electrolyte disturbances were considered exclusion criteria.

A complete medical history was obtained at admission, including age, gender, known or recently discovered hypertension (HTN), diabetes mellitus (DM), heart diseases (atrial fibrillation, valvular or ischemic heart disease), and previous stroke/TIA or cigarette smoking, general and complete neurologic examinations were done for every patient recruited. The duration of hospital stay was also calculated for every patient.

Routine laboratory investigations were done to exclude any medical problems. All patients have undergone non-contrast computed tomography (CT) on the brain to assess the stroke type (hemorrhagic or ischemic), size, and site of infarction.

Regarding clinical scores, mSOAR score was calculated for each patient on admission. It is a simple score that uses clinical and imaging data in the initial assessment of the patient. It is composed of the designated scores for each of the following 5 domains: stroke subtype (score 0 for ischemic infarction and 1 for hemorrhagic stroke) OCSP project classifications (score 0 for lacunar and partial anterior circulation, score 1 for posterior circulation, and score of 2 for total anterior circulation strokes), age (patients with age 65 years or less were given score 0, score 1 for age range from 66 to 85 years, and score 2 for patients aged more than 85 years), mRS (mRS from 0 to 2 had score 0, mRS 3–4 had score 1, and mRS 5 had score 2) and NIHSS (NIHSS 0–4 had score 0, NIHSS 5–10 had score 1, and NIHSS 11 or more had score 2). The score of mSOAR is calculated by combining the score of the 5 domains.

The recovery after stroke has been evaluated using mRS, which ranges from 0 to 6, by measuring global disability, and it has also been used as the primary endpoint in randomized clinical studies of emerging acute stroke therapies [6].

Statistical analysis was conducted using SPSS 22nd edition, quantitative variables were presented in mean and standard deviation for parametric data, median and range for non-parametric data. Paired comparison of modified Rankin score was conducted using Friedman's test. Sensitivity analysis was conducted to predict incidence of complications using mSOAR score. Logistic regression model was conducted to assess predictors of incidence of complications. Any p value < 0.05 was considered significant.

Results

Patients varied in age from 28 to 87 years, averaging 61.3 years. The majority of patients were males representing 62%, whereas females represent 38%. Regarding risk factors, HTN was the most prevalent, present in 50% of patients, followed by cigarette smoking (38%), DM (36%), heart illnesses (32%) that predispose to stroke (AF, valvular or ischemic heart disease), and history of previous TIA or stroke (21%).

Seventy-eight patients (78%) were found to have ischemic stroke, while 22 patients (22%) had intracerebral hemorrhage. Most of patients (61%) were ≤ 65 years, 37% of them were between 66 and 85 years and only 2% were ≥ 86 years. Regarding stroke subtypes, lacunar and partial anterior circulation strokes represented the major type and were found in 77 patients (77%), twelve patients (12%) had posterior circulation stroke, while 11 patients (11%) had total anterior circulation stroke.

The majority of patients (66%) had an initial NIHSS of ≥ 11. Initial NIHSS was 5–10 in 32% of cases and only 2% of cases had an initial NIHSS of 4 or below. Ninety-three percent of patient had pre-stroke mRS of 0–2 and 7% had pre-stroke mRS of 3–4. Length of hospital stay ranged from 3 to 30 days, averaging 13.5 days.

After combining the scores of the previous 5 domains, we could calculate the mSOAR score for every patient. The items of the mSOAR score and total score are summarized in Tables 1 and 2.

A significant difference was seen between the mRS at discharge and 1 month following follow-up. As depicted in Table 3, Post hoc analysis confirmed that the difference is significant ($p = 0.0001$).

A significant positive correlation between the mSOAR score and the mRS on discharge and after the first month after the stroke onset was shown ($p = 0.0001$). Furthermore, there was a significant positive correlation ($p = 0.0001$) between the mSOAR score and the duration

Table 1 Items of mSOAR score

	Assigned mSOAR score	Number	Percentage (%)
(1) Stroke subtype			
(a) Ischemic	0	78	78
(b) Hemorrhagic	1	22	22
(2) Age			
(a) ≤ 65	0	61	61
(b) 66–85	1	37	37
(c) ≥ 86	2	2	2
(3) OCSP			
(a) Lacunar and partial anterior	0	77	77
(b) Posterior	1	12	12
(c) Total anterior	2	11	11
(4) NIHSS			
(a) 0–4	0	2	2
(b) 5–10	1	32	32
(c) ≥ 11	2	66	66
(5) Pre-stroke mRS			
(a) 0–2	0	93	93
(b) 3–4	1	7	7
(c) 5	2	0	0

mSOAR modified SOAR (Stroke subtype, Oxfordshire community stroke project, Age and modified Rankin score), *OCSP* Oxfordshire Community Stroke Project classification, *mRS* Modified Rankin Scale, *NIHSS* National Institutes of Health Stroke Scale

Table 2 Total mSOAR score

Total mSOAR score	Number	Percentage (%)
1	14	14
2	37	37
3	26	26
4	13	13
5	10	10

mSOAR modified SOAR (Stroke subtype, Oxfordshire community stroke project, age and modified Rankin score)

Table 3 Paired comparison of modified Rankin Scale on discharge and after 1 month

	Median	Min	Max	*P* value	Post hoc
Discharge mRS	4	1	6	0.0001	P1 = 0.0001
One-month mRS	3	0	6		P2 = 0.044

mRS: modified Rankin Scale

of hospital stay. In this study, 9 patients died during the first month of stroke onset. A higher mSOAR score was related to mortality within 30 days after stroke onset; however, this relation was insignificant ($p = 0.069$).

Table 4 Prediction of moderate-severe discharge disability and 1-month disability

mSOAR cut off point	Sensitivity (95% CI)	Specificity (95% CI)	PPV	NPV
mRS ≥ 4 at discharge				
≥ 2	98.3 (95–100)	31.7 (17.5–45.9)	67.4	92.9
≥ 3	74.6 (63.5–85.7)	87.8 (77.8–97.8)	89.8	70.6
≥ 4	39 (26.6–51.4)	100 (96.4–100)	100	53.2
= 5	16.9 (7.3–26.5)	100 (96.4–100)	100	45.6
mRS ≥ 4 after 1 month				
≥ 2	97.6 (92.9–100)	22 (12–32)	46.5	92.9
≥ 3	80.5 (68.4–92.6)	72.9 (61.6–84.2)	67.3	84.3
≥ 4	53.7 (38.4–69)	98.3 (95–100)	95.7	75.3
= 5	24.4 (11.3–37.5)	100 (95.7–100)	100	65.6

95% CI 95% confidence interval, *PPV* positive predictive value, *NPV* negative predictive value, *mRS* modified Rankin Scale, *mSOAR* modified SOAR (Stroke subtype, Oxfordshire community stroke project, age and modified Rankin score)

The mSOAR score is a great predictor of moderate-to-severe disability at discharge and 1 month after the stroke (mRS ≥ 4). Table 4 demonstrates that each point increase in mSOAR score was related to a significant increase in the discharge and 1-month mRS as a measure of disability ($p = 0.0001$).

Discussion

In this study, the average patient's age was 61.3 years, with male predominance. These results agreed with the distribution of stroke patients, whose median age is 65.6 years, with male predominance among all age groups [7]. Furthermore, HTN was shown to be the most prevalent risk factor for stroke, followed by DM and heart disease. These results are in concordance with many studies [8–11]. Moreover, a history of a previous TIA and/or stroke was reported in 21% of patients. This was in agreement with Khan and Vohra, who reported a history of previous TIA in 29.9% of ischemic and 10.7% of hemorrhagic stroke patients [12]. 38% of the patients were reported to be cigarette smokers. This finding was close to the study reported by Rotimi et al. [13], that 1446 stroke patients (26.5%) of studied patients were cigarette smokers.

Ischemic stroke was more common than hemorrhagic stroke (78% and 22%, respectively). This finding agrees with previous studies that stated that the incidence of ischemic stroke is more than that of hemorrhagic stroke [14–16]. Furthermore, a study conducted in Qena (Egypt) showed that 86% had ischemic strokes, whereas 14% had hemorrhagic strokes [17].

According to the OCSP classification, lacunar or partial anterior circulation strokes were the most prevalent among our patients, followed by posterior and total

anterior circulation strokes. Our findings were almost identical to a previous study, who found that lacunar and partial anterior strokes represented 77%, whereas posterior stokes and total anterior strokes represented 14% and 9%, respectively [18].

In this study, an initial NIHSS $\geq$ 11 was more than stated by Olavarría et al. [19], who found that 54% of patients had an initial NIHSS of 4 or below, and Zöllner et al. [20] stated that 49% of patients had an initial NIHSS of 5 or below. This difference can be attributed to a smaller sample size and resource availability which may limit the admission of patients with mild strokes. We found that most patients had an mSOAR score of 2, followed by 3 and 1. Our results were identical to Abdul-Rahim et al. [5].

We observed that the mSOAR score is an effective predictor of moderate-to-severe disability at discharge and 1 month following stroke onset. This is consistent with the findings of Thaller and Mitchell, who found that each rise in mSOAR score was related to considerably worsening discharge disability; hence, it is an excellent predictor of discharge disability [3]. Another study also found that a one-point increase in the mSOAR score significantly increased the risk of poor prognosis at discharge [21].

mSOAR score is significantly correlated with the length of hospital stay. This observation is in accordance with the study stated by Thaller and Mitchell, who said that higher mSOAR scores were linked with a prolonged median hospital stay for survivors [3]. Also, Kwok et al. showed that increasing SOAR score (the older version of mSOAR) had a significantly higher mean and median for hospital length of stay [22].

Higher mSOAR scores were linked to mortality within 30 days after stroke onset, although the relationship was insignificant. Wang et al. revealed that the mSOAR score predicts discharge and 90-day mortality and that the risk of mortality increases as mSOAR scores increase [23]. In addition, Abdul-Rahim et al. also showed that an mSOAR score is an excellent predictor for 90-day mortality [5]. Our results differed from these studies because we did not find a statistical significance for the mSOAR score in predicting the 30-day mortality rate. This might be due to the limited sample size, the low number of mortalities in our study, and the short follow-up period (30 days versus 90 days in other studies).

mSOAR score is an excellent tool for prediction of discharge disability and mortality after cerebrovascular stroke, combining the different elements of the score (including data related to stroke type, stroke location, initial stroke severity and disability) made it easy to integrate in clinical practice and useful for admission prognosis discussion with the patient.

The small sample size and short follow-up duration was a limitation of this study. Larger sample size and longer follow-up duration may improve the reliability of mSOAR. Clinical factors related to stroke outcome as for example, stroke size and uncontrolled hyperglycemia could be assessed in relation to the mSOAR score in future research. mSOAR score also does not include non-neurologic aspects that may significantly impact a patient's outcome (for example, respiratory complications).

Conclusion

The mSOAR score is an easily calculated score that has been proven to be an excellent and accurate tool for predicting the severity of post-stroke disability as well as the length of hospital stay.

Abbreviations

CT	Computed tomography
DM	Diabetes mellitus
HTN	Hypertension
mRS	Modified Rankin Score
mSOAR	Modified SOAR (Stroke subtype, Oxfordshire community stroke project, Age and modified Rankin score)
NIHSS	National Institutes of Health Stroke Scale
OCSP	Oxfordshire Community Stroke Project
TIA	Transient ischemic attacks

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Author contributions

ME, HA and GH contributed to the conception, design, drafting, and revising of the manuscript. AE contributed to data acquisition. HA, GH and AE contributed to data analysis and interpretation. HA and GH contributed to manuscript writing. All authors read and approved the final manuscript.

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Availability of data and materials

The data used and analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Permission from the research ethics committee, Faculty of Medicine, Cairo University, was obtained on 18th of January 2022. Participants had singed a written informed consent.

Consent for publication

Not applicable.

Competing interests

The authors have no conflict of interests to disclose.

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